# Photon Statistics and Atmospheric Turbulence

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- Theory
- Comparison with existing LANL photon counting data
- Ongoing work

# Photon Counting Statistics at the Receiver

$$p(n) = \int dq \frac{q^n e^{-q}}{n!} P(q)$$

$p(n)$ = probability of counting $n$ photons in a time interval $T$

Turbulence theory predicts that $P(q)$ is a log-normal distribution:

$$P(q) = \frac{1}{q\sigma\sqrt{2\pi}} e^{-[\ln(q/\bar{q}) + \frac{1}{2}\sigma^2]^2/2\sigma^2}$$

$$\sigma^2 = 1.23 C_n^2 \left(\frac{2\pi}{\lambda}\right)^{7/6} L^{11/6}$$

**Presenter: Peter Milonni**

Calculations of (a) fade/surge statistics and (b) variance in photon number for 10 km paths and 10-ms intervals give good agreement with LANL measurements when reasonable assumptions are made for the level of turbulence.

## Ongoing Work

- Extend theory beyond plane waves
- Include effect of background radiation
- Measure *p(n)* for different path lengths (important!)
- Inversion of measured *p(n)* to obtain *P(n)* (log-normal?)